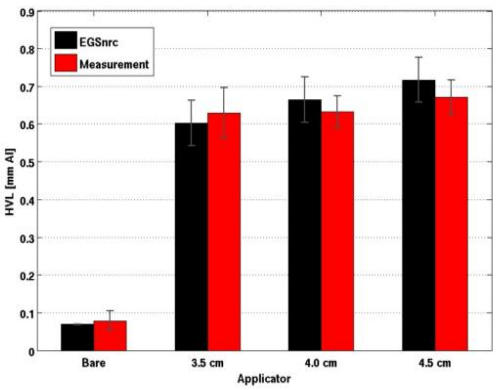
a model of a low energy x-ray source (INTRABEAM, Carl Zeiss) using the EGSnrc Monte Carlo (MC) code is presented, and the model is validated, in air, using detailed attenuation measurements.

Materials and Methods: The INTRABEAM source was modeled using cavity, an EGSnrc user code. Photon fluence spectra emitted by the source were scored across a circular region (r=0.5 cm) for bare probe and spherical applicators of 3.5 cm, 4.0 cm, and 4.5 cm diameter. INTRABEAM spectra generated with EGSnrc agree well with published results generated using GEANT4. From the simulated spectra, HVL was determined analytically by calculating the attenuation of air-kerma for a given thickness of aluminum and source-to-detector air gap. Simulated HVL values are generally in agreement with published experimental studies, and the observed discrepancies may be related to setup particularities. Our own attenuation curve measurements were performed using a PTW model 23342 parallel-plate soft x-ray chamber (0.02 cm^3). The photon beam was collimated with a 16 cm lead cylinder surrounding the INTRABEAM source, and foils of high purity aluminum were placed at the exit of the collimator. The HVL was determined by curve fitting of the experimentally determined attenuation data.

Results: Simulated HVLs for the bare probe and spherical applicators are in good agreement with measured values, to within statistical and systematic uncertainties. It was found that the presence of the lead collimator has a non-negligible effect on HVL measurement for the spherical applicators, due to the emission of fluorescent x-rays. The investigation of systematic errors for the MC model showed that the uncertainty of polyetherimide density, position of collimator along the beam axis, and source-to-detector distance have an effect on the calculated HVL values.



Conclusions: The INTRABEAM source spectra determined using the EGSnrc code agree well with published GEANT4 results. The INTRABEAM bare probe and applicator HVLs predicted by the EGSnrc model calculations are consistent with the values determined experimentally in this study.

PO-0821

Configuration of a treatment planning system: study and dosimetric evaluation for treatments with small fields

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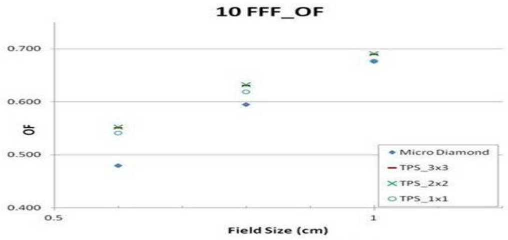
Purpose/Objective: Evaluate the accuracy of a dose calculation algorithm implemented in a treatment planning system (TPS) currently in use and the essential parameters used to calculate dose and monitor units. This was finalized to assess critical factors that affect TPS and to have an indication on how to perform beam commissioning focused on planning with small fields used in stereotactic radiotherapy.

Materials and Methods: To evaluate TPS (Eclipse AAA.11.0.30, Varian Medical Systems) accuracy for small fields, a comparison between calculation and experimental measures was performed. Profiles and output factors (OF) were measured in water with a MicroDiamond (PTW) detector in jaw defined open fields ranging from 10x10 to 0.6x0.6 cm^2 with 6MV, 6FFF and 10FFF photon beams generated by an EDGE Linac (Varian). TPS accuracy was evaluated for different measured OF and spot size (SS) values (1; 0.8; 0.5; 0 mm) included in beam data. This analysis was repeated for MLC shaped open fields down to 0.5x0.5cm^2. In a second phase the different TPS configurations were evaluated. 24 RapidArc (RA) test plans (4 for each configurations) were optimized, calculated and compared to the relative delivered dose distribution using Gamma analysis (GI).

Results: Measurements of OF has a strong impact on MU calculation accuracy for small fields: adding in the TPS OF up to 1x1 cm^2 (smaller field available in beam configuration) led to a better agreement between measured and calculated values up to 0.6x0.6 cm^2 calculated field. The mean percentage difference between measured and calculated OF values passes from 2.2±0.4% to 0.1±0.1% for 1x1 field and from 15.8±1.3% to 13.3±0.8% for 0.6x0.6 cm^2. The primary source size parameter (spot size) included in beam configuration affects all calculated data for small fields (both OF and profiles). A value of 0 mm (the one recommended by default) was proved not to be the most appropriate compared to values between 0.5 and 0.8 mm. Mean percentage difference for OF values goes, for 1x1 cm^2, from 0.4±0.05% for SS 0mm to 0.1±0.11% and 0.2±0.1% for SS 0.5mm and 0.8mm respectively and, for 0.6x0.6 cm^2, from 13.4±0.8% for SS 0mm to 11.3±1.2% and 8.1±0.8% for SS 0.5mm and 0.8mm respectively.

Study of MLC shaped fields shows a difference between calculated and experimental values: no TPS configuration reduces these discrepancies. It seems to be necessary to improve MLC modeling and parameters in TPS, to better describe measured data.

RA stereotactic plans showed an acceptable agreement between delivered and planned dose for every TPS configuration: GI range from 99.8% to 91.9%.



Conclusions: Eclipse AAA.11.0.30 showed acceptable characteristics for small fields calculation. Adequate tuning of the studied configuration parameters in TPS is strongly suggested for plan calculation accuracy with small fields. Our results suggest that the feasibility of adding fields smaller than 1x1 cm^2 in beam configuration should be investigated.

PO-0822

Towards 'matched' gantries in scanning beam protontherapy

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Purpose/Objective: Having 'matched' performances among treatment rooms in a radiotherapy department is desirable in order to simplify the beam characterization and model validation for the treatment planning system (TPS) and to move patients among gantries without changing the treatment plan and so saving time for patient-specific QA. The current work aimed at evaluating whether in our proton therapy (PT) center we could use a single beam model in the TPS for all the gantries.

Materials and Methods: At our PT facility two gantries are available, both equipped with active pencil beam scanning. To compare the beam properties of the two gantries we did perform:

i) Range measurements, using a Multi-Layer Ionization Chamber, from 70MeV to 226MeV in steps of 10MeV;

ii) Machine output determinations, with both Ionization Chamber (i.e.: Markus model) and a Faraday Cup, in steps of 10MeV from 70MeV to 226MeV;

iii) Phase-space measurements over the whole energy range in air at different positions (at isocenter plane and ±20cm from isocenter), with a scintillating screen coupled to a CCD camera.

In addition a clinically realistic plan (deep seated intracranial lesion) was delivered in both gantries on a heterogeneous anthropomorphic phantom embedding gafchromic films, allowing to get information on 2D dose planes. Profiles comparison and gamma analysis was carried-out. The treatment plan was designed in XiO TPS, using a single beam model, built starting from data gathered in one of the two gantries.

Results: In general, a good agreement was found between the two gantries. Discrepancies in terms of machine output over the entire energy range - expressed as beam monitor calibration results - were on average 0.34% (range: 0.03% ÷ 0.98%, see figure1). An average range difference of 0.5mm (range: 0.0mm ÷ 0.8mm) was measured, mainly due to slight discrepancies of nozzle water equivalent thickness, with the largest differences being associated with higher energies. Spot size (i.e.: σ) was quite similar between the rooms (differences always less than 0.6mm, regardless of energy and measurement position - see table1 for details at isocenter plane),

		ISOCENTER plane		
Energy	Parameter	Gantry1	Gantry2	Abs Diff (mm)
70MeV	σx (mm)	6,80	6,90	0,10
	σy (mm)	6,73	6,56	0,18
100MeV	σx (mm)	5,03	5,20	0,17
	σy (mm)	5,03	4,92	0,11
130MeV	σx (mm)	3,87	4,25	0,37
	σy (mm)	4,18	4,06	0,11
160MeV	σx (mm)	3,54	3,68	0,13
	σy (mm)	3,56	3,44	0,12
190MeV	σx (mm)	3,06	3,12	0,06
	σy (mm)	3,18	2,97	0,21
226MeV	σx (mm)	2,72	2,70	0,02
	σy (mm)	2,78	2,72	0,06

Table1. Absolute differences in terms of spot size (σx and σy) between the two gantry rooms at several energies, measured at isocenter plane.

while spot shape and beam divergence showed somewhat a different behavior (an example is given in figure1), also depending on the energy. An acceptable agreement was found between 2D dose distributions delivered on the anthropomorphic phantom in the two gantries, both in terms of profiles comparison and gamma analysis results. With agreement criteria of 3%-3mm, a gamma passing rate of around 95% was obtained (see figure1).